

4.0 WATER QUALITY EVALUATION

4.1 INTRODUCTION

A water quality evaluation was performed as part of the Cool Creek Watershed Management Plan. This task included a review of the general condition of the riparian corridor, an evaluation of floodplain development issues in the watershed, and water quality sampling at selected locations in the watershed, and a general overview of pending stormwater quality related regulations.

4.2 RIPARIAN CORRIDOR EVALUATION

The term riparian refers to anything connected with or immediately adjacent to the banks of a stream or other body of water. A riparian forest buffer encompasses the area from the streambank to the area of trees, shrubs, and herbaceous vegetation located upslope from the body of water. Buffers are established and managed to reduce the impact of adjacent land use. A buffer serves several important functions: it preserves the stream's natural characteristics, protects water quality, and improves habitat for plants and animals on land and in the water.

For a good portion of its main stem, Cool Creek has a healthy riparian forested buffer. From the mouth at the White River upstream to 116th Street, the stream corridor is forested. Between 116th Street and 126th Street, Cool Creek runs through a golf course. There are some forested areas along the creek in this reach, but not to the extent seen in other reaches. Upstream of 126th Street to approximately SR 32 there are healthy riparian buffers, though there are segments with limited forest cover.

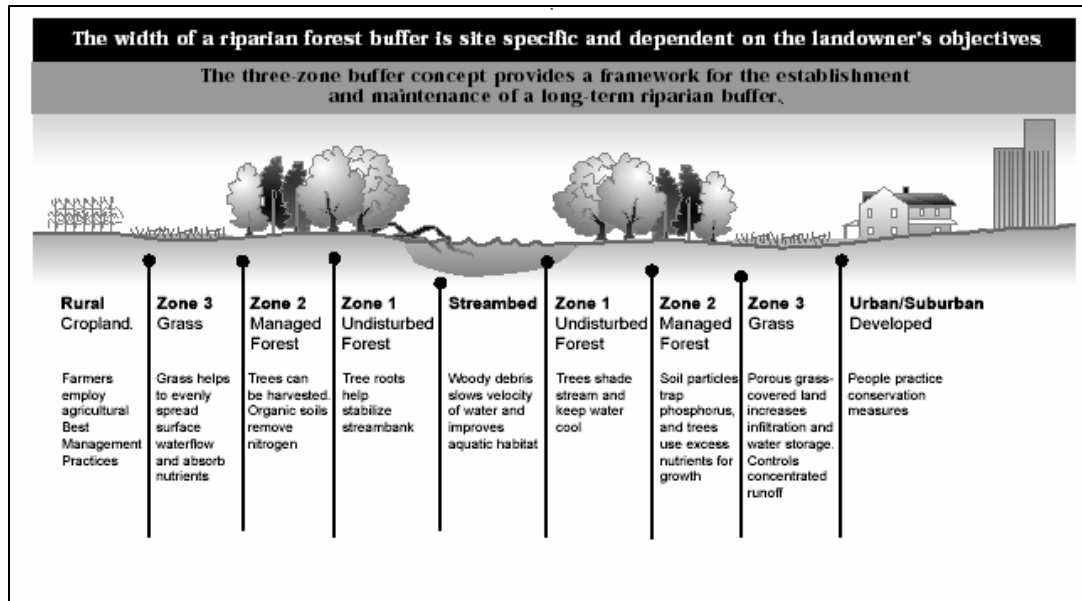
Upstream of SR 32, Cool Creek has limited riparian vegetation and is farmed to the edge of the stream. Several segments of Cool Creek have been channelized and straightened. The photographs below illustrate the difference in riparian vegetation for the lower and upper reaches of Cool Creek. As the agricultural tracts in the upper watershed are developed, stream buffers should be considered. Figure 4-1 shows an illustration of the various zones and benefits of a properly planned riparian buffer.



*Forested riparian buffer along
Cool Creek east of SR 431*



*No riparian buffer – Cool
Creek south of 191st Street*



Source: University of Maryland, Cooperative Extension

Figure 4-1
Riparian Forest Buffer Illustration

4.3 FLOODPLAIN DEVELOPMENT

Floodplain development concerns tie directly to preservation of the riparian buffers along Cool Creek (and its tributaries). Filling of floodplains can cause loss of flood storage and riparian habitat. As noted previously, Hamilton County has an ordinance that prohibits filling of land in the floodplains of its regulated drains. It would be appropriate for Carmel and Westfield to adopt similar policies for floodplains under their jurisdiction. This would provide a uniform policy and would help preserve existing riparian buffers. Many communities have adopted buffer ordinances to protect headwater streams where floodplains are often narrow and floodplain protection alone may not adequately protect buffer systems. This management practice would also help comply with IDEM water quality regulations.

4.4 WATER QUALITY SAMPLING

Stream sampling was performed at three locations in the watershed: 186th Street, 146th Street, and 116th Street. The 186th Street sampling point captures mostly agricultural runoff. The 146th Street sampling point includes runoff from most of the Town of Westfield. The 116th Street sampling point includes 98 percent of the watershed.

Two wet weather events (03-25-02 and 8-19-02) and two dry weather events (06-21-02 and 09-09-02) were selected for the water quality sampling. The total rainfall during the two wet weather events was approximately 0.7 inches (3-25-02 event) and 2.9 inches (8-19-02 event).

Samples were collected by Clark Dietz staff and were delivered with appropriate chain of custody to Test America, Inc. for laboratory analysis. Samples were analyzed in accordance with EPA standard methods. Grab samples analyzed for the following parameters:

- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Chromium, Hexavalent
- Cyanide
- Nitrogen (Ammonia, Kjeldahl, Nitrate, Organic, Total)
- Oil & Grease
- Ph
- Phenol
- Phosphorus (Dissolved and Total)
- Solids (Suspended and Dissolved)
- Fecal Coliform
- Fecal Streptococcus
- E. Coli
- Metals

Table 4-1 summarizes the results of the sampling program. Complete reports from the testing laboratory can be found in Appendix D. The highlighted values in Table 4-1 represent sample results that were somewhat elevated as compared to national averages. The following is an evaluation and interpretation of some of the specific parameters that were tested in the Cool Creek watershed. Several references were used in interpretation of the sampling data:

- Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPS, Metropolitan Washington Council of Governments, July 1987.
- Urbanization and Water Quality: A Guide to Protecting the Urban Environment, Terrene Institute, March 1994.
- Polluted Urban Runoff: A Source of Concern, University of Wisconsin-Extension, 1997.
- Watershed Protection Techniques Vol. 3, No. 1, Microbes and Urban Watersheds: Concentrations, Sources, & Pathways, Center for Watershed Protection, April 1999.
- Stormwater Magazine: The Journal for Surface Water Quality Professionals, The ABCs of Water-Quality Assessment in Georgia, March/April 2002.
- National Management Measures to Control Nonpoint Source Pollution from Urban Areas – Draft, U. S. Environmental Protection Agency, July 2002.

4.4.1 Oxygen Demand (BOD and COD)

BOD and COD levels were found at levels below national averages. BOD and COD are measures of the amount of oxygen used by macroinvertebrates and bacteria in processing organic matter in streams. Organic matter comes from both natural and human sources. Natural sources include riparian vegetation like leaves falling in the stream. Human sources might include sewage, pet wastes, nutrients from fertilizers, and litter. High BOD levels result in low dissolved oxygen in streams, which in turn degrades water quality and lowers diversity of aquatic organisms. Typically, BOD levels from 3 to 5 mg/l are considered moderately clean. Levels below 3 mg/l are considered very clean.

TABLE 4-1
STREAM SAMPLING RESULTS
COOL CREEK WATERSHED MANAGEMENT PLAN

Parameter	Typical Wet Weather Values Reported in Literature	116th Street Crossing				146th Steet Crossing				186th Street Crossing			
		Dry Weather		Wet Weather		Dry Weather		Wet Weather		Dry Weather		Wet Weather	
		06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02
BOD mg/l	12 ⁽¹⁾	<5	<5	5.1	5.5	<5	<5	5	6.9	<5	<5	5	5.4
COD mg/l	91 ⁽¹⁾	<10	<1	10	59	<10	9.8	10	81	<10	11	10	32
Nitrogen, Kjelhdahl mg/l	2.35 ⁽¹⁾	0.56	0.3	2.3	3.0	0.84	0.54	2.1	3.6	0.73	0.69	1.1	2.1
Nitrogen, Nitrate mg/L	0.96 ⁽¹⁾	0.65	0.47	0.9	0.69	0.85	0.16	1.2	0.81	1.8	0.65	2.2	1.2
Nitrogen, Ammonia mg/L	0.26 - 1.1 ⁽²⁾	<0.10	<0.10	0.88	0.14	<0.10	<0.10	5.1	0.16	<0.1	<0.10	4.3	0.29
Nitrogen, Total mg/l	3.31 ⁽¹⁾	1.2	0.77	3.2	3.7	1.7	0.7	3.3	4.4	2.5	1.3	3.3	3.3
Nitrogen, Organic mg/l	1.25 ⁽³⁾	0.56	0.3	1.4	2.9	0.84	0.49	<0.10	3.4	0.73	0.66	<0.10	1.8
Phosphorus, Dissolved mg/l	0.16 ⁽¹⁾	<0.05	<0.05	<0.05	0.15	<0.05	<0.05	<0.05	0.21	0.067	0.07	<0.05	0.28
Suspended Solids mg/L	100 ⁽⁴⁾	<5	<5	120	490	<5	<5	61	580	<5	10	11	160
Dissolved Solids mg/l	N/R	440	530	280	120	390	430	290	210	360	490	390	140
E.coli /100 ml	11,000 ⁽⁵⁾	170	>1600	900	1600	220	>1600	300	1600	170	>1600	900	>1600
Fecal Streptococcus /100 ml	35,000 ⁽⁵⁾	13	3	120	92	12	<1	240	960	5	4	<10	1700
Chromium, Hex mg/l	0.007 ⁽⁶⁾	0.01	<0.01	<0.01	0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.012
Phenol mg/	0.008 - 0.11 ⁽⁶⁾	0.012	0.022	<0.01	0.025	<0.01	<0.01	<0.01	0.017	<0.01	<0.01	<0.01	0.018
Copper mg/	0.047 ⁽¹⁾	<0.02	<0.02	<0.02	0.033	<0.02	<0.02	<0.02	0.025	<0.02	<0.02	<0.02	<0.02
Nickel mg/	0.012 ⁽⁶⁾	<0.01	<0.01	<0.01	0.018	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc mg/	0.176 ⁽¹⁾	<0.05	<0.05	<0.05	0.095	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

(1) Nationwide Urban Runoff Program. 2300 monitored storms at 22 sites across the nation. US EPA 1983.

(2) Range is for newer suburban sites and older urban areas, as reported by Metropolitan Washington Council of Governments, 1987.

(3) Newer suburban sites, as reported by Metropolitan Washington Council of Governments, 1987.

(4) U. S. EPA database for general urban runoff.

(5) Center for Watershed Protection database of 34 recent urban stormwater monitoring studies, 1999.

(6) Metro Seattle as reported in Fundamental of Urban Runoff Management: Technical and Institutional Issues, Terrene Institute, 1994.

N/R = Not Reported

Cells shaded yellow with bold border indicate values somewhat elevated as compared to national averages found in the literature

The Cool Creek sampling results ranged from 5 to 6.9 mg/l during wet weather and were less than 5 during dry weather. The National average for BOD is 12 mg/l. Higher BOD levels are often associated with older, highly impervious areas with outdated combined sewers. Neither Carmel nor Westfield has combined sewers which may be why BOD levels are significantly below the national average.

4.4.2 Nutrients (Phosphorus and Nitrogen)

The average concentration of nutrients from all three sites and both storm events are somewhat higher than national averages reported in the literature, which may warrant further evaluation. Nutrients such as phosphorus and nitrogen are essential nutrients needed by all living plants and animals. Excess nutrients cause extensive algal growth which can in turn cause eutrophication, which in turn increases BOD. Phosphorus comes from several sources, including human wastes, animal wastes, industrial wastes, fertilizers, and human disturbance of land. Ammonia nitrogen is often found in areas where duck and geese excretions are high. Human sewage, caused by failing septic systems and illegal sanitary sewer cross-connections, is a source of nitrates. Fertilizers and runoff from animal feedlots and barnyards are also important sources of nitrates (and ammonia).

Water bodies with total phosphorus present at levels above 0.1 mg/l may be at risk for eutrophication. Typically, concentrations of nitrate nitrogen above 10 mg/l, ammonia nitrogen above 2 mg/l, and Kjeldahl nitrogen above 2 mg/l are a concern and may warrant actions to identify and limit inputs into the receiving streams. The Cool Creek sampling data show Kjeldahl nitrogen was generally above 2 mg/l during wet weather. Nitrate nitrogen was generally below 2 mg/l (well below the 10 mg/l level of concern), and tended to be higher at the 186th Street sampling location. Ammonia nitrogen was high (4.3 and 5.1 mg/l at the 186th Street and 146th Street locations) during the March 25, 2002 sampling event. Early spring lawn fertilizing may be a partial explanation for this result. The August 19, 2002 sampling event showed ammonia nitrogen levels below 0.3 mg/l.

4.4.3 Sediment

The sediment sampling performed in the Cool Creek watershed showed varying results. Typical urban runoff values for total suspended solids (TSS) are around 100 mg/l. For the March 25, 2002 wet weather event, TSS concentrations were 120, 61, and 11 mg/l at 116th Street, 146th Street, and 186th Street. These values confirm higher TSS from urban areas versus cropland areas. For the August 19, 2002 event, TSS concentrations were much higher – 490 mg/l at 116th Street, 580 mg/l at 146th Street and 160 mg/l at 186th Street. It should be noted, this storm event was not a typical rainfall event, with 2.5 to 2.9 inches of rain. A typical storm event in central Indiana is about 0.65 inches.

High concentrations of suspended sediment in streams cause many adverse impacts. Suspended solids change the color of streams from nearly clear to red-brown. High turbidity causes streams to lose their ability to support diverse aquatic organisms. Suspended solids can also directly impact aquatic life in terms of clogging fish gills, reducing growth rates and decreasing resistance to disease. Excessive sediment deposited in the stream bed can prevent egg and larvae development.

The leading sources of sediment in existing urban areas are industrial sites, commercial development and freeways. But by far the highest loads of sediment come from areas under construction. Construction sites have high erosion rates and high delivery rates. Typical erosion

rates for construction sites are 35 to 45 tons per acre disturbed per year compared to 1 to 10 tons per acre per year for cropland. The delivery rate of sediment is also much higher in construction sites as compared to cropland because ditches and sewers are typically constructed in the first phase of a site development project. Typically 50% to 100% of soil eroded from a construction site is delivered to a lake or stream, compared to only 3% to 10% of the soil from cropland delivered to lakes or stream. This fact illustrates the importance of properly planned, installed and maintained erosion and sediment controls on construction sites.

4.4.4 Bacteria (E. Coli and Fecal Streptococcus)

Bacteria results found in the Cool Creek samples are consistent with the national averages. E. Coli levels were above standards for recreational use (235), ranging from 300 to >1600 counts/100 ml during wet weather. One of the dry weather events (9/9/02) was also well above standards with a reported value of >1600 counts/100 ml. The laboratory was unable to perform counts higher than 1600 due to sample size limitations. Literature on national averages reports a mean E. Coli value of approximately 11,000 counts/100 ml.

Bacteria are indicators of the presence of fecal wastes in surface waters. Escherichia coli (E. Coli) is in the coliform family of bacteria. Fecal streptococci (also known as Enterococci) are another bacteria group found in feces. Coliform bacteria are only an indicator of a potential public health risk, and not an actual cause of disease. Coliform bacteria are also used by most states as a standard for drinking water, shellfish consumption or water contact recreation. Indiana uses E. Coli as its standard (235 counts/100 ml for water contact recreational use of a stream).

The Center for Watershed Protection (see reference previously listed) developed a database of 34 more recent monitoring studies for bacteria. For E. Coli, the group mean was reported to be almost 11,000 counts/100 ml. Nearly every individual stormwater runoff sample exceeded bacteria standards. Bacteria sources in urban watersheds include human sources and non-human sources. Human sources include those caused by combined and sanitary sewer overflows, illegal sanitary connections to storm drains, transient dumping of wastewater, and failing septic systems. Most bacteria present in stormwater runoff are generally assumed to be of non-human origin, unless there are inappropriate human sewage discharges present in an urban watershed. Non-human sources include dogs, cats, raccoons, rats, beaver, geese, ducks, pigeons and other animals. Dogs in particular are often found to be a major source of coliform bacteria. Several studies have found dogs to be the primary source of fecal coliforms in urban watersheds. Dogs have also been found to be significant hosts for Giardia, Salmonella, and other pathogens. Geese, ducks, and gulls are also speculated to be a major bacterial source in urban areas, particularly at lakes and stormwater ponds where large resident populations become established. Relatively little data is available to quantify whether geese and ducks are a major source. Livestock can also still be a major source of bacteria, particularly those areas of the urban fringe that have horse pastures or "hobby" farms. These types of land uses exist in the upper reaches of the Cool Creek watershed.

The Center for Watershed Protection publication lists four conclusions as a result of their research on microbes in urban watershed: 1.) It is exceptionally difficult to maintain beneficial uses of water in the face of even low levels of watershed development, given the almost automatic violation of bacterial water quality standards during wet and dry weather. 2.) Bacteria levels in urban stormwater are so high that watershed practices would need to be exceptionally efficient (99% removal rate) to meet standards during wet weather. 3.) A lot of "detective work" would be needed to narrow down the lengthy list of potential bacteria suspects. 4.) There is little

understanding about the actual relationship between bacterial indicators and the risk to public health in urban watersheds.

4.4.5 Trace Metals

Copper, nickel, and zinc were found above detection limits at the 116th Street sampling location for the August 19, 2002 sampling event. Copper was also found at the 146th Street location during this event. The concentrations for copper and zinc were below averages reported in the literature for typical urban runoff. Nickel was found above detection limits at the 116th Street location during the August 19, 2002 sampling event. Chromium was also found above detection limits at the 116th Street location and the 186th Street location for this event. Nickel and chromium were above typical values reported in the literature.

Trace metals can be a concern because of their toxic effects on aquatic life, and their potential to contaminate drinking water supplies. Sources of metals include roofing materials, downspouts, galvanized pipes, metal plating, paints, wood preservatives, catalytic converters, brake linings, and tires. The most common metals found in urban runoff are lead (has been declining since unleaded gas has been implemented), cadmium, copper, and zinc. The primary source of many metals in urban runoff is vehicle traffic. Concentrations of zinc, cadmium, chromium and lead appear to be directly correlated with the volume of traffic.

4.4.6 Organic Compounds

Phenol is an organic compound that is a main chemical component of oil. Sources of phenol include oil spill, runoff carrying oil from streets, and other oil related activities. Phenol was detected in both dry and wet weather sampling events. The concentration was consistent with urban runoff values reported in the literature.

4.4.7 Summary of Sampling Results

The following observations and conclusions can be made from the sampling of Cool Creek:

- The constituents and concentrations of pollutants found in Cool Creek are generally comparable to urban and urbanizing watersheds across the country.
- Nutrients appear to be somewhat higher than national averages. This could be the result of excess fertilizer use coupled with agricultural runoff from the upper watershed. Public education regarding proper lawn care may be an appropriate follow up activity.
- Suspended solids were very high for one of the sampled events, though this was an atypical storm event. Proper erosion and sediment control on construction sites, in addition to streambank restoration, will help to control suspended solids levels.
- Bacteria levels exceed those required for recreational contact. This finding was expected as nearly all urban watersheds have bacteria counts that greatly exceed health standards for swimming. Efforts should be made to track and reduce human sources of bacteria that may result from failing septic systems, illegal sanitary sewer connections, and other sources. Public education on proper disposal of pet waste would also be a best management practice to help reduce bacteria levels.
- Other management practices, such as enhanced stormwater management practices, will further reduce stormwater runoff pollution into Cool Creek and its tributaries.

4.5 PHASE II NPDES STORMWATER REGULATIONS

In the late 1980s and early 1990s, federal regulations were promulgated (through the US Environmental Protection Agency (EPA) requiring municipalities to develop programs to reduce pollutants in stormwater runoff. The initial regulation applied only to communities with a population of 100,000 or larger (called Phase I communities). In 1999, a federal regulation was passed that addresses Phase II communities (those with populations greater than 10,000). Hamilton County, Carmel, and Westfield will all be regulated under this program.

IDEM is responsible for enforcement of the Phase II stormwater program in Indiana. On August 6, 2003, the final regulation became effective as 327 IAC 15-13 and titled "Rule 13 - Storm Water Run-Off Associated with Municipal Separate Storm Sewer System Conveyances." A Notice of Intent (NOI) letter and other associated initial application documents were due to IDEM by November 4, 2003. The Rule 13 regulation is to be implemented through six minimum control measures, summarized in Table 4-2 below.

**Table 4-2
Rule 13 Six Minimum Control Measures Summary**

<i>Public Education and Outreach</i>	Distributing educational materials and performing outreach to inform citizens about the impacts polluted stormwater runoff discharges can have on water quality.
<i>Public Participation and Involvement</i>	Providing opportunities for citizens to participate in program development and implementation, including effectively publicizing public hearings and/or encouraging citizen involvement.
<i>Illicit Discharge Detection and Elimination</i>	Developing and implementing a plan to detect and eliminate illicit discharges to the storm sewer system. Includes developing a storm sewer system map and informing the community about hazards associated with illicit discharges and improper disposal of waste.
<i>Construction Site Runoff Control</i>	Developing, implementing, and enforcing an erosion and sediment control program for construction activities that disturb one or more acres of land.
<i>Post-Construction Runoff Control</i>	Developing, implementing, and enforcing a program to address discharges of post-construction stormwater runoff from new development and redevelopment areas. Applicable controls could include preventative actions such as protecting sensitive areas or the use of structural BMPs such as wet ponds or constructed wetlands.
<i>Pollution Prevention/Good Housekeeping</i>	Developing and implementing a program with the goal of preventing or reducing pollutant runoff from municipal operations. (e.g., regular street sweeping, reduction in the use of pesticides or street salt, or frequent catch-basin cleaning).

Rule 13 requires the development of a comprehensive written document called a Stormwater Quality Management Plan (SWQMP). The SWQMP is divided into three parts:

Part A: Initial Application (due along with the NOI by November 4, 2003)

- Listing of entities covered by the permit
- Schedule of activities
- Proposed budget allocation and summary of identified funding sources

Part B: Baseline Characterization and Report (due within 180 days from receivership date of NOI)

- An investigation of land use and assessment of any stormwater BMP locations
- Identification of known sensitive water areas
- A review of known existing and available monitoring data of area receiving waters
- Identification of areas causing or likely to cause pollutant problems
- Assessment of BMP effectiveness

Part C: Program Implementation (due within 365 days from receivership date of NOI)

- Initial evaluation of the stormwater program
- Detailed program description for each minimum control measure
- Timetable for program implementation milestones
- Schedule for on-going characterization of receiving waters
- Narrative and mapped description of the boundaries covered by permit
- Estimate of the linear feet of open ditch or pipe
- Summary of the types of BMPs that will be allowed in developing areas
- Narrative or tabular summary of post-installation performance standards for BMPs
- Summary of the current and projected stormwater budget and funding sources
- Summary of measurable goals for each minimum control measure

All three entities in the Cool Creek watershed have submitted Notice of Intent (NOI) letters and Part A of the SWQMP, with Hamilton County and the City of Carmel being co-permittees. *The Cool Creek Watershed Management Plan will be useful in support of Rule 13 application and implementation efforts.*

The water quality sampling program, the riparian corridor evaluation, streambank erosion assessment and other data collected on this project is directly applicable to development of the Part B: Baseline Characterization and Report requirement. Recommendations in Chapter 7 regarding changes to stormwater detention requirements and land use and planning are directly applicable to post-construction runoff control requirements.